2.32 COMMAND GUIDANCE

Three discrepancies were found between the block diagrams provided in the documentation and the code. One effects the input to the azimuth channel of Injection Mode, variable BSUM1. One effects the input to the azimuth channel for Dynamic Compensation, variable BTR and one effects the final calculation of Dynamic Compensation for the elevation channel, variable DCOMPE. (These are listed as discrepancies based on the assumption that the classified block diagrams which describe the system of interest were correct as provided in the external documentation.)

The overall code quality is good with only a few corrections recommended for the internal documentation.

The table listed below summarizes the desk-checking and software testing verification activities for each subroutine in the Command Guidance Functional Element (FE). The two results columns contain checks if no discrepancies were found. Where discrepancies were found, the desk check results column contains references to discrepancies listed in Table 2.32-4, while the test case results column lists the number of the relevant test case in Table 2.32-6. More detailed information on the results is recorded in these tables.

TABLE 2.32-1. Verification Results Summary.

Design Element	Code Location	Desk Check Result	Test Case ID	Test Case Result
32-1 Injection Mode	DRVG8 671-672 692-699 703-785 806-821 834-849 865-867 871-873 1115-1118 1121 1130-1133 1136	D1	32-19 thru 32-24, 32-40, 32-42	32-19
32-2 Low Altitude Mode	DRVG8 577-578 641-667 1128-1129	4	32-15, 32-17, 32-18, 32-47	4
32-3 Dynamic Compensation	DRVG8 885-944 1122,1127 1140-1142 1137 1144-1145	D2, D3	32-28, 32-29, 32-44, 32-45	32-28 32-29

TABLE 2.32-1. Verification Results Summary. (Contd.)

Design Element	Code Location	Desk Check Result	Test Case ID	Test Case Result
32-4 Guide Mode	DRVG8 789-804 822-832 850-860 868, 874 1119-1120 1125-1126 1134-1135 1153-1154	4	32-25 thru 32-27, 32-41, 32-43	4
Angle Calculations	DRVG8 483-572	4	32-5 to 8 32-11 to 14	4
Mode Selection	DRVG8 582-637 986-1023 1149-1152	4	32-3, 32-4, 32-16, 32-32 to 34 32-48	32-16
Adjusted Guidance Commands	DRVG8 948-949 961-972 1028-1043 1123-1124 1138-1139	4	32-2 32-30, 32-31, 32-35, 32-46	4
Update MTR	DRVG8 1051-1112 1156-1173	4	32-36 to 39, 32-49 32-50	4
Initialization/Limiting	CONSYS DRVG8 402-473 553-558 675-688 714-717 738-740 756-759 779-781 895-898 904-909 922-925 951-956	4	32-1, 32-9, 32-10	4

2.32.1 Overview

After a surface-to-air missile has been launched, it must be directed or guided so that it intercepts the target. If the missile employes command guidance the radar site which launched the missile transmits guidance commands which direct the missile on an intercept course with the target. These guidance commands consist of control surface deflections.

The guidance logic changes as the missile/target relative position and velocity relationships change.

ESAMS implementation of the Command Guidance FE is done primarily in Subroutines CONSYS, GAP8, RK4G, RELTGT and DRVG8. CONSYS chooses the correct guidance routines based on the missile system being simulated. GAP8 directs the operation of the correct guidance routines and is the source of the final autopilot commands. RK4G and RELTGT implement the Runge-Kutta integration for intermediate time steps. DRVG8 is the primary Command Guidance routine which models the guidance block diagrams. All subroutines used for this FE are described in Table 2.32-2.

TABLE 2.32-2. Subroutine Descriptions.

MODULE NAME	DESCRIPTION
CONSYS	Selects system-specific guidance routine, GAP, according to the value of the guidance type index IGTYP.
DRVG8	Guidance derivative routine that implements computation of the system's guidance computer state variables.
EULRM	Integrates missile position and velocity for intermediate time steps.
GAP8	Specific guidance control routine that sets up guidance integration control variables, calls the integrator and converts the resulting in deflections to voltages for use by the autopilot.
RELTGT	Computes the target-missile-site relative geometry at the integration time points for RK4G.
RK4G	Integrates by Runge-Kutta integration the guidance computer state equations for one time step, using the guidance integration control variables and the guidance derivative routine (DRVG8).

2.32.2 Verification Design Elements

Design elements defined for the Command Guidance FE are listed in Table 2.32-3. The first four design elements are fully described in Section 2.32.2 of the ASP II for ESAMS.

TABLE 2.32-3. Command Guidance Design Elements.

SUBROUTINE	DESIGN ELEMENT	DESCRIPTION
DRVG8 RELTGT RK4G	32-1 Injection Mode	Computes azimuth and elevation guidance commands while in Injection Mode.
DRVG8 RK4G	32-2 Low Altitude Mode	Computes Elevation Bias used to modify elevation input commands.
DRVG8 RELTGT RK4G	32-3 Dynamic Compensation	Computes term used to compensate for accelerations operating on the missile.
DRVG8 RELTGT RK4G	32-4 Guide Mode	Computes azimuth and elevation guidance commands while in Guide Mode.
DRVG8	Angle Calculations	Computes the azimuth and elevation angles required as inputs

TABLE 2.32-3. Command Guidance Design Elements. (Contd.)

SUBROUTINE	DESIGN ELEMENT	DESCRIPTION
DRVG8	Mode Selection	Based on given conditions, guidance mode is selected.
GAP8 DRVG8	Adjusted Guidance Commands	Filters pitch and yaw guidance commands and rotates into current fin plane orientation.
DRVG8	Update MTR	Models missile tracking servos and updates based on tracking errors.
DRVG8	Initialization/Limiting	Initializes state space variables used in guidance computations and limits variables.

2.32.3 Desk Checking Activities and Results

The code implementing this FE was manually examined using the procedures described in Section 1.1 of this report. Any discrepancies discovered are described in Table 2.32-4.

TABLE 2.32-4. Code Discrepancies.

DESIGN ELEMENT	DESK CHECK RESULT
32-1 Injection Mode	D1. The coded equation for computing BSUM1 is, BSUM1 = SIGB*COS(BOREEL(ITRKR)) while the block diagram has BSUM1 = SIGB.
32-3 Dynamic Compensation	D2. The coded equation for computing DCOMPE is, DCOMPE = GC(56)*VZERO*(2.0*ETDTL + ETRD2) while the block diagram has: DCOMPE = GC(56)*VZERO*(2.0*GC(56)*VZERO*ETDTL + ETRD2). D3. The coded equation for computing BTR is, BTR = BOREAZ(ITRKR) while the block diagram has: BTR = DTB + BOREAZ(ITRKR)

Except as noted in Table 2.32-5 below, overall code quality and internal documentation were evaluated as good. Subroutine I/O were found to match the ASP II descriptions.

TABLE 2.32-5. Code Quality and Internal Documentation Results.

Subroutine	Code Quality	Internal Documentation
DRVG8	Good overall. Variables ET and BT are created to be used in Dynamic Compensation but are not used anywhere, BOREEL and BOREAZ are used directly.	• Subroutine is referred to as DRVG**G** in Purpose. • A justification of how and why specific variables are initialized is lacking. • The comment on lines 518-522 does not make sense. • How the variables HSIGF, HBETF, HSIGFD and HBETFD are used to test for a mode switch should be explained with a comment. Variable Description Changes: • THATL is *Initial* target to site Az angle • ANGERP and ANGERY under COMMON/ECMV/ are not used • AZERR and ELERR should be replace with AZERRT and ELERRT under COMMON/ENVRN/ • XTS, YTS and ZTS should be deleted under COMMON/RELSIT/ • IPMODE should be added under COMMON/SIMVI/ • TIME should be added under COMMON/TARG/
GAP8	OK	PURPOSE says “to set up target and radar parameters and ...”, this statement is no longer true. Variable Description Changes: • FTIME should be the only variable under COMMON/MISSIL/ • COMMON/RELSIT/ should be deleted

2.32.4 Software Test Cases

All software testing was performed by running the entire ESAMS model in debug mode. For these tests, ESAMS was run using a sample input file for the specific missile of interest.

TABLE 2.32-6. Software Test Cases for Command Guidance.

Test Case ID	Test Case Description
32-1	OBJECTIVE: Check for selection of correct guidance routine. PROCEDURE: 1. Run ESAMS using ESAMS8.INP. 2. Break in subroutine CONSYS and step to line 97. 3. Note the value of FTIME and TBALL and observe proper operation of IF statement. 4. for FTIME < TBALL, observe call to GAP8 on line 131. 5. Return to line 97, deposit a value of FTIME < TBALL (if necessary). 6. Step to line 107 and deposit a value of 16 into IGTYPE. 7. Observe operation of code. 8. Repeat Steps 1 and 2. 9. Step to line 97 and deposit a value of FTIME > TBALL and observe operation of code. VERIFY: 1. Subroutine GAP8 is called when FTIME < TBALL. 2. Model stops operation at Step 7 when incorrect IGTYPE is input. 3. Autopilot commands are set to 0 when FTIME > TBALL. RESULT: OK
32-2	OBJECTIVE: Check calculation of autopilot inputs EK1 & EK2 in Subroutine GAP8. PROCEDURE: 1. Run ESAMS using ESAMS8.INP. 2. Break in subroutine GAP8 and step to line 105. 3. Observe the setting of variables T, DLT & N. 4. Step to line 111, observe the value of FTIME. 5. For FTIME < 1.0, observe the setting of EK1 & EK2 to 0. 6. Repeat Step 2. 7. Step to line 111 and deposit a value of 1.5 into FTIME. 8. Step to line 113 and observe the values of EK1 (on right side of Equation) and AC(1). 9. Step to line 114 and observe the value of EK2 (on right side of Equation). 10. Independently calculate values of EK1 & EK2 and compare to computed values on lines 113 and 114. VERIFY: 1. Autopilot commands are set to 0 when FTIME < 1.0. 2. Independent calculation of EK1 & EK2 match computed values when FTIME > 1.0 RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-3	OBJECTIVE: Check variable incrementation and DO LOOP operation in Subroutine RK4G. PROCEDURE: 1. Run ESAMS using ESAMS8.INP. 2. Break in subroutine RK4G. 3. Observe incrementation of I, T and TD. 4. Observe operation of DO LOOPs. VERIFY: 1. Variables I, T and TD are incremented correctly. 2. DO LOOPs operate correctly. RESULT: OK
32-4	OBJECTIVE: Check operation of RK4G in the performance of Runge-Kutta integration. PROCEDURE: 1. Create an off-line duplicate of RK4G. 2. Use off-line duplicate of RK4G to solve a differential equation with an exact solution. 3. Compare results of step 2 with exact solution of differential equation. VERIFY: RK4G performs Runge-Kutta integration correctly. RESULT: OK
32-5	OBJECTIVE: Check integration of missile position and velocity in Subroutine RELTGT. PROCEDURE: 1. Run ESAMS using ESAMS8.INP. 2. Break into Subroutine RELTGT and step to line 139 and note the values sent to Subroutines TGTPOS, TGTVEL and TGTREL. 3. Step to line 151 and note the values of TX, TY, TZ, TXD, TYD, TZD, and TIME. 4. Step to line 160, note the values of DLLT, DEL202 on lines 151 and 154, respectively, and note the values of XDDOT, YDDOT, ZDDOT, TX, TY, TZ, TXD, TYD, TZD, TV and TV2 returned from Subroutine EULRM. 5. Using Euler integration, independently calculate integrated values of missile position and velocity and compare to values returned from Subroutine EULRM. VERIFY: 1. Missile position and velocity are integrated correctly using EULER integration. 2. The time, within the model framework, at which the target and missile position are computed are the same. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

<table>
<tr><th>Test Case ID</th><th>Test Case Description</th></tr>
<tr><td>32-6</td><td>OBJECTIVE: Check calculation of missile-to-target relative positions in Subroutine RELTGT.
PROCEDURE:
1. Run ESAMS using ESAMS8.INP.
2. Note the values of XTM, YTM, ZTM, RTMH2, RTMH, RTM2, and RTM for each of the cases below.
<table>
<tr><th>Case</th><th>XT</th><th>YT</th><th>ZT</th><th>TX</th><th>TY</th><th>TZ</th></tr>
<tr><td>1</td><td>-200</td><td>200</td><td>50</td><td>200</td><td>100</td><td>100</td></tr>
<tr><td>2</td><td>200</td><td>100</td><td>100</td><td>-200</td><td>200</td><td>50</td></tr>
<tr><td>3</td><td>-200</td><td>200</td><td>50</td><td>-400</td><td>-100</td><td>100</td></tr>
<tr><td>4</td><td>-200</td><td>200</td><td>200</td><td>500</td><td>-300</td><td>150</td></tr>
</table>
VERIFY:
1. XTM, YTM & ZTM, RTMH and RTM are computed correctly.
2. The relative distances computed are consistent in all cases.
RESULT: OK</td></tr>
<tr><td>32-7</td><td>OBJECTIVE: Check calculation of missile-to-target relative velocities in subroutine RELTGT.
PROCEDURE:
1. Run ESAMS using ESAMS8.INP.
2. Depositing the values below, note the values of XTMDOT, YTMDOT and ZTMDOT for each of the cases below:
<table>
<tr><th>Case</th><th>XTDOT</th><th>YTDOT</th><th>ZTDOT</th><th>TXD</th><th>TYD</th><th>TZD</th></tr>
<tr><td>1</td><td>-100</td><td>0</td><td>0</td><td>200</td><td>150</td><td>20</td></tr>
<tr><td>2</td><td>-100</td><td>- 40</td><td>- 20</td><td>-200</td><td>40</td><td>20</td></tr>
<tr><td>3</td><td>0</td><td>100</td><td>0</td><td>200</td><td>0</td><td>0</td></tr>
<tr><td>4</td><td>100</td><td>0</td><td>-20</td><td>-200</td><td>20</td><td>20</td></tr>
</table>
VERIFY:
1. XTMDOT, YTMDOT and ZTMDOT are computed correctly.
2. The relative velocities computed are consistent in all cases.
RESULT: OK</td></tr>
</table>

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

<table>
<tr><th>Test Case ID</th><th>Test Case Description</th></tr>
<tr><td>32-8</td><td>OBJECTIVE: Check calculation of target-to-site and missile-to-site relationships.
PROCEDURE:
1. Run ESAMS using ESAMS8.INP.
2. Depositing the values below, note the values of XTS, YTS, ZTS, and RTS for each of the cases below:
<table>
<tr><th>Case</th><th>XT</th><th>YT</th><th>ZT</th><th>XSJ</th><th>YSJ</th><th>ZSJ</th></tr>
<tr><td>1</td><td>400</td><td>200</td><td>50</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>2</td><td>-400</td><td>-200</td><td>50</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>400</td><td>200</td><td>50</td></tr>
<tr><td>4</td><td>-400</td><td>200</td><td>1000</td><td>200</td><td>-200</td><td>50</td></tr>
</table>3. Depositing the values below, note the values of XMS, YMS, ZMS and RMS for each of the bases below:
<table>
<tr><th>Case</th><th>TX</th><th>TY</th><th>TZ</th><th>XSJ</th><th>YSJ</th><th>ZSJ</th></tr>
<tr><td>1</td><td>400</td><td>200</td><td>50</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>2</td><td>-400</td><td>-200</td><td>50</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>3</td><td>400</td><td>-300</td><td>1000</td><td>0</td><td>100</td><td>50</td></tr>
<tr><td>4</td><td>-400</td><td>300</td><td>1000</td><td>50</td><td>50</td><td>0</td></tr>
</table>VERIFY:
1. XTS, YTS, ZTS and RTS are computed correctly.
2. The relative positions of target-to-site are consistent in all cases.
3. XMS, YMS, ZMS and RMS are computed correctly.
4. The relative positions of missile-to-site are consistent in all cases.
RESULT: OK</td></tr>
</table>

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-9	OBJECTIVE: Check initialization of variables on first pass through DRVG8. PROCEDURE: 1. Run ESAMS using ESAMS8.INP. 2. Break into Subroutine DRVG8, observe initialization procedures on first pass. 3. Return to subroutine DRVG8 and note incrementation of INTFLG. VERIFY: 1. Variable KST is set to 1 on line 403. 2. Variables correctly initialized between lines 407 and 451. 3. Variables correctly initialized between lines 553 and 558. 4. Variables correctly initialized between lines 675 and 688. 5. Variables correctly initialized between lines 714 and 717. 6. Variables correctly initialized between lines 738 and 740. 7. Variables correctly initialized between lines 756 and 759. 8. Variables correctly initialized between lines 779 and 881. 9. Variables correctly initialized between lines 895 and 898. 10. Variables correctly initialized between lines 904 and 909. 11. Variables correctly initialized between lines 922 and 925. 12. Variables correctly initialized between lines 951 and 956. 13. On second pass through DRVG8, INTFLG is incremented. RESULT: OK
32-10	OBJECTIVE: Check limiting of selected integral variables in DRVG8. PROCEDURE: 1. Run ESAMS using ESAMS8.INP. 2. Break into subroutine DRVG8, observe limiting of variables between lines 453 and 458. 3. Change value of TMP to check limiting of XI(7) and XI(22). 4. Observe limiting of variables between lines 470 and 473. VERIFY: Variables are limited correctly. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-11	OBJECTIVE: Check calculation of missile range, elevation, and azimuth angles in DRVG8. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break in subroutine DRVG8, observe the conversion of missile range from meters to kilometers on line 477. 3. Observe the value of THEM using the following conditions. ZMS / RMS / Expected Value of Them 0 / 0 / Set equal to GAMMA2 1000 / 1000 / 1.570796 (90∞) 1000 / 3000 / 0.33984 -10 / 1000 / -0.01 4. Observe the value of THAM using the following conditions. XMS / YMS / Expected Value Of THAM 0 / 0 / Set equal to BOREAZ(ITRKR) 200 / 100 / 0.45365 -200 / 100 / 2.67795 -200 / -100 / 3.60524 200 / -100 / 5.81954 VERIFY: 1. Missile range converted to kilometers in Step 2. 2. Missile elevation and azimuth angles are computed correctly. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

<table>
<tr><th>Test Case ID</th><th>Test Case Description</th></tr>
<tr><td>32-12</td><td>OBJECTIVE: Check elevation angular inputs to guidance computer for both narrow and wide beam selections.
PROCEDURE:
1. Run ESAMS using ESAMS8.INP file.
2. As test proceeds, deposit the following values:
Case BOR34M BOREEL(2) THEM
1 .1 .2 .3
2 .1 .3 .2
3 .3 .2 .1
4 .2 .1 .3
5 .2 .3 .3
3. For each test case, observe the values of DEM, DME and DMTE.
4. Observe the value of DTE1 and SIGE.
5. Repeat Steps 2, 3, and 4, setting LNAROW Flag to TRUE before observation of SIGE.
VERIFY:
1. Values of DEM, DME and DMTE are computed correctly.
2. Values of SIGE are computed correctly based on LNAROW Flag.
RESULT: OK</td></tr>
<tr><td>32-13</td><td>OBJECTIVE: Check azimuth angular inputs to guidance computer for both narrow and wide beam selections.
PROCEDURE:
1. Run ESAMS using ESAMS8.INP file.
2. As test proceeds, deposit the following values:
Case BOR14M BOREAZ(2) THAM
1 .1 .2 .3
2 6.2 .1 .01
3 .01 6.2 .1
4 .1 .01 6.2
3. For each test case, observe the values of DBM, DMB and DMTB.
4. Observe the value of DTB1 and SIGB.
5. Repeat Steps 2, 3, and 4, setting LNAROW Flag to the before observation of SIGB.
VERIFY:
1. Values of DBM, DMB and DMTB are computed correctly.
2. Values of SIGB are computed correctly based on LNAROW Flag.
RESULT: OK</td></tr>
</table>

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-14	OBJECTIVE: Check calculation of target angular error in both azimuth and elevation. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break in Subroutine DRVG8, step to line 539 and set IOPT equal to 1. 3. Observe the values of DTE and DTB computed on lines 546 and 547. 4. Repeat Step 2, set IOPT equal to 0. 5. Repeat Step 3. 6. Step to line 549, set DTE to a value greater than GC(131) and observe the limiting of DTE. VERIFY: 1. DTE and DTB set to 0 in Step 3. 2. DTE and DTB computed correctly when IOPT is set to 0. 3. DTE is correctly limited in Step 6. RESULT: OK
32-15	OBJECTIVE: Check calculation of RRM from look-up table. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into subroutine DRVG8, step to line 575, observe the value of T for first entry into TLU. 3. Observe the value of RRM returned from first call to TLU and compare to expected value of 0.0. 4. Repeat Step 3, deposit the following values into T. T — Expected Value of RRM 3.6 — .702 10.2 — 3.96 15.8 — 7.272 57.0 — 10.0 5. For each value of T, observe the value of RRM returned from TLU. VERIFY: RRM values correctly interpolated from look-up table. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-16	OBJECTIVE: Check Guidance Mode selection in DRVG8. PROCEDURE: 1. Run ESAMS using modified ESAMS8.INP file. 2. Break in Subroutine DRVG8 and step to line 599. 3. Set T = 0.7 and BOREEL = 0.35, observe Guidance Mode Set. 4. Continue until model returns to Subroutine DRVG8. 5. Set T = 0.8. 6. Observe IPMODE value. 7. Continue to next call to DRVG8. 8. Set T = 0.7, BOREEL = .005, RTS = 5000 and VCL = 90, observe Guidance Mode Set. 9. Repeat Steps 4, step to line 540 and note value of IOPT. 10. Repeat steps 5, 6, and 7. 11. Set T = 0.7, BOREEL = 0.026, RTS = 7500 and IECM = 1, observe Guidance Mode Set. 12. Repeat Steps 4, 5, 6, and 7. 13. Set T = 0.7, BOREEL = 0.26, RTS = 7500 and IECM = 0, observe Guidance Mode Set. 14. Repeat Steps 4, 5,6, and 7. 15. Set T = 0.9. 16. Observe operation. VERIFY: 1. Guidance Mode set to LOS at Step 3 and IPMODE set to 2. 2. Guidance Mode set to LOALTM/LATPHI at Step 8, IOPT set to 1 and IPMODE set to 3. 3. Guidance Mode set to LOALTM/LHMODE at Step 10 and IPMODE set to 4. 4. Guidance Mode set to LOALTM/LZOOM at Step 12 and IPMODE set to 5. 5. Guidance Mode not changed, IPMODE still set to 5. RESULT: OK - Except, IOPT (indicate optical tracking) not set when LATPHI mode is set.

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-17	OBJECTIVE: Check calculation of elevation bias for all modes in DRVG8. PROCEDURE: 1. Run ESAMS using modified ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 641. 3. Set LOS = .TRUE. 4. Observe the value of ER. 5. Return to subroutine DRVG8. 6. Step to line 644, set LHMODE = TRUE, set EMT = 0 and observe the value of ER. 7. Repeat step 5. 8. Step to line 644, set LHMODE = TRUE, set EMT to a value which will be greater than ET + DTE1 and observe the value of ER. 9. Repeat Step 5, step to line 577. 10. Note the values of DBAR and DLR. 11. Step to line 654 and set LZOOM = TRUE, note the values of RRM and ER. 12. Repeat Steps 9 and 10. 13. Step to line 659 and set LATPHI = TRUE, note the values of RRM and ER. VERIFY: 1. ER set to 0 at Steps 4 and 6. 2. ER equal to (EMT - (ET + DTE1)) at Step 8. 3. Using values of GC(12), (13), (14), ER computed correctly at Step 11. 4. Using values of GC(13)-(16), ER computed correctly at Step 13. RESULT: OK
32-18	OBJECTIVE: Check calculation of EMT from look-up table. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Step to line 645, observe the value of T for first entry into TLU. 3. Observe the value of EMT returned from first call to TLU and compare to expected value of 52.56 (for T = 0). 4. Repeat Step 2, deposit the following values into T T — Expected Value of EMT 3.6 — 52.56 5.8 — 29.062 8.3 — 16.429 86.0 — 12.01 5. For each value of T, observe the value of EMT returned from TLU. VERIFY: EMT correctly interpolated from look-up table. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-19	OBJECTIVE: Check input and output of Filter Block 2 for both azimuth and elevation. PROCEDURE: 1. Run ESAMS using modified ESAMS8.INP file. 2. Break in Subroutine DRVG8, step to line 672. 3. Observe the values of SIGE, ER, and ESUM1. 4. Step to next line, observe the values of SIGB, BOREEL (ITRKR) and BSUM1. 5. Step to line 694, set BSUM2 to a value greater than GC(23) and observe limiting of ESUM2. 6. Step to line 697, set BSUM 2 to a value greater than GC(127) and observe limiting of ESUM2. VERIFY: 1. Based on block diagram of elevation guidance, ESUM1 is equal to SIGE - ER. 2. Based on block diagram of azimuth guidance, BSUM1 is equal to SIGB. 3. ESUM2 and BSUM2 are limited correctly. RESULT: 1. OK 2. BSUM1 is not equal to SIGB as displayed in block diagram. Code has BSUM1 = SIGB*COS(BOREEL(ITRKR). 3. OK
32-20	OBJECTIVE: Check Injection Mode for elevation channel. PROCEDURE: 1. Run ESAMS using modified ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 706. 3. Note the values of HEG, ESUM2, GC(13), and RRM. 4. Step to line 731 and note the values of HEG2, HEHE, and FTD. 5. Step to line 733 and note the values of HEGBAR, XI(7), and GC(24). 6. Step to line 784 and note the value of HFE. 7. Step to line 807 and set LWIDE = TRUE. 8. Step to line 808 and note the values of KGEINJ, GC(54), and GC(53). 9. Repeat Steps 2 - 6. 10. Step to line 807 and set LWIDE = FALSE. 11. Step to line 874 and note the values of KGEINJ and HFE1. 12. Repeat Step 2. 13. Step to line 709, set HEG to a value greater than GC(26) and observe the limiting of HEG. 14. Step to line 734, set HEGBAR to a value greater than GC(40) and observe the limiting of HEGBAR. VERIFY: 1. Calculation of HEG (Step 3), HEG2 (Step 4), HEGBAR (Step 5), HFE (Step 6) and KGEINJ (Steps 8 and 11) are correct based on Injection Mode block diagram. 2. HEG and HEGBAR are limited correctly based on Injection Mode block diagram. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-21	OBJECTIVE: Check calculation of FEHE and HFE1 in Injection Mode elevation channel. PROCEDURE: 1. Run ESAMS using modified ESAMS8.INP file. 2. Break in Subroutine DRVG8 and step to line 721. 3. Deposit the following values into HEG: Manually Calculated HEG Value of FEHE 0 0 15 18.214 28 34.0 80 61.0 132 88.0 300 134.56 600 190.0 4. For each value of HEG, note the value of the FEHE computed. 5. Deposit the following values into HFE: Manually Calculated HFE Value of HFE1 0 0 9 11.97 10 17.0 18 57.0 26.6100.0 30100.0 6. For each value of HFE, note the value of HFE1 computed. VERIFY: 1. The value of FEHE matches manually calculated value. 2. The value of HFE1 matches manually calculated value. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-22	OBJECTIVE: Check calculation of FTD from look-up table. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break in Subroutine DRVG8, step to line 730. 3. Observe the values of FTD returned from first call to TLU and compare to expected value of 0.33 (for T = 0). 4. Repeat Step 2, deposit the following values into T: T — Expected Value Of FTD 1.2 — .414 6.0 — 0.868462 12.0 — 0.965 50.0 — 1.0 5. For each value of T, observe the value of FTD returned from TLU. VERIFY: FTD values correctly interpolated from look-up table. RESULT: OK
32-23	OBJECTIVE: Check Injection Mode for azimuth channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 748. 3. Note the values of HBG, BSUM2, GC(13) and RRM. 4. Step to line 772 and note the values of FBHB and HBG2. 5. Step to line 774 and note the values of HBGBAR, XI(22), and GC(25). 6. Step to line 785 and note the value of HFB. 7. Step to line 835 and set LWIDE = TRUE. 8. Step to line 836 and note the values of KGBINJ, GC(54), and GC(53). 9. Repeat Steps 2 - 6. 10. Step to line 855 and set LWIDE = FALSE. 11. Step to line 847 and note the values of KGBINJ and HFB1. 12. Repeat Step 2. 13. Step to line 751, set HBG to a value greater than GC(128) and observe the limiting of HBG. 14. Step to line 775, set HBGBAR to a value greater than GC(47) and observe the limiting of HBGBAR. VERIFY: 1. Calculation of HBG (Step 3), HBG2 (Step 4), HBGBAR (Step 5), HFB (Step 6), and KGBINJ (Steps 8 and 11) are correct based on azimuth channel block diagram. 2. HBG and HBGBAR are limited correctly based on azimuth channel block diagram. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-24	OBJECTIVE: Check calculation of FBHB and HFB1 in Injection Mode - azimuth channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break in Subroutine DRVG8 and step to line 763. 3. Deposit the following values: Manually Calculated HBG Value of FBHB 0.0 0 15.0 15.0 40.0 27.736 68.0 42.0 120.0 49.1 300.0 60.0 4. For each value of HBG, note the value of FBHB computed. 5. Deposit the following values into HFB. Manually Calculated HFB Value of HFB1 0.0 0.0 9.0 11.97 10.0 17.0 18.0 57.0 26.0100.0 30.0100.0 6. For each value of HFB1, note the value of HFB1 computed. VERIFY: 1. The value of FBHB matches manually calculated value. 2. The value of HFB1 matches manually calculated value. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-25	OBJECTIVE: Check Guide Mode for elevation channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break in Subroutine DRVG8, step to line 789. 3. Note the values of HELOS and HELAT. 4. Based on what LOS is set to, note the value of HEBAR. 5. Step to line 832, note the value of HEBARI. 6. Step to line 829, note the value of HEBAR1. 7. Step to line 830, note the values of HEBAR2 and FKT. 8. Step to line 831, note the values of KGEGUI. 9. Repeat Steps 2. 10. Step to line 799, set HEBAR to a value greater than GC(55) and observe the limiting of HEBAR. VERIFY: 1. Calculations of HELOS (Step 3), HELAT (Step 3), HEBARI (Step 5), HEBAR1 (Step 6), HEBAR2 (Step 7), and KGEGUI (Step 8) are correct based on Guide Mode - elevation channel block diagram. 2. HEBAR is limited correctly based on azimuth channel block diagram. RESULT: OK
32-26	OBJECTIVE: Check calculation of FKT from look-up table for Guide Mode azimuth channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 822. 3. Observe the value of T for first entry into TLU. 4. Observe the value of FKT returned from first call to TLU and compare to expected value of 1.057 (for T = 0). 5. Repeat Step 2, deposit the following values into T: Expected Value T Of FKT 2.8 1.7592 8.3 5.7965 20.6 19.7436 48.0 23.171 6. For each value of T, observe the value of FKT returned from TLU. VERIFY: FKT values correctly interpolated from look-up table. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-27	OBJECTIVE: Check Guide Mode for azimuth channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break in Subroutine DRVG8, step to line 796. 3. Note the value of HBBAR. 4. Step to line 850, note the value of HBBARI. 5. Step to line 856, note the value of HBBAR1. 6. Step to line 858, note the values of FKT and HBBAR2. 7. Step to line 859, note the value of KGBGUI. 8. Repeat Step 2. 9. Step to line 802, set HBBAR to a value greater than GC(55) and observe the limiting of HBBAR. VERIFY: 1. Calculation of HBBAR (Step 4), HBBARI (Step 5), HBBAR2 (Step 6), and KGBGUI (Step 7) are correct based on azimuth channel block diagram. 2. HBBAR is limited correctly based on a azimuth channel block diagram. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-28	OBJECTIVE: Check dynamic compensation for elevation channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 887, set LATPHI = TRUE. 3. Note values of XI(13), GC(17), ER, ET1, and DCOMPE. 4. Repeat Step 2, set LATPHI = FALSE. 5. Step to line 892, note the values of ETR, DTE, and BOREEL (ITRKR). 6. Step to line 901, note the values of HFE, XI(26), and GC(87). 7. Step to line 913, note the value of ETDTL. 8. Step to line 928, note the value of ETDT2, XI(8), GC(74), and ETDTL. 9. Step to line 938, note the values of ETRD2 and FKT. 10. Step to line 942, note the values of DCOMPE, GC(56), and VZERO. 11. Repeat Step 4. 12. Step to line 915, set ETDTL to a value greater than GC(59) and observe the limiting of ETDTL. 13. Step to line 931, set ETDT2 to a value greater than GC(55) and observe the limiting of ETDT2. VERIFY: 1. Calculation of ET1 and DCOMPE (Step 3) is correct based on elevation channel block diagram for LATPHI mode. 2. Calculation of ETR (Step 5), HEE (Step 6), ETDTL (Step 7), ETDT2 (Step 8), ETRD2 (Step 9), and DCOMPE (Step 10) are correct based on elevation block diagrams. 3. ETDTL and ETDT2 are limited correctly based on elevation block diagram. RESULT: OK except DCOMPE does not agree with block diagram. Equation is coded: DCOMPE = GC(56)*VZERO*(2.0*ETDTL + ETRD2) Block diagram has: DCOMPE = GC(56)*VZERO*(2.0*GC(56)*VZERO*ETDTL + ETRD2)

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-29	OBJECTIVE: Check dynamic compensation for azimuth channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 887, set LATPHI = TRUE. 3. Note the value of DCOMPB. 4. Repeat Step 2, set LATPHI = FALSE. 5. Step to line 893, note the values of BOREAZ (ITRKR) and BTR. 6. Step to line 902, note the values of HBB, XI(27), and GC(87). 7. Step to line 912, note the values of XI(30), BTDT, and BOREEL (ITRKR). 8. Step to line 929, note the values of XI(23), GC(74), BTDTL, and BTDT2. 9. Step to line 939, note the value of FKT and BTRD2. 10. Step to line 943, note the values of GC(56), VZERO, and DCOMPB. 11. Repeat Step 4. 12. Step to line 918, set BTDTL to a value greater than GC(59) and observe the limiting of BTDTL. 13. Step to line 934, set BTDT2 to a value greater than GC(55) and observe the limiting of BTDT2. VERIFY: 1. Calculation of DCOMPB (Step 3) is correct based on azimuth channel block diagram for LATPHI Mode. 2. Calculation of BTR (Step 5), HBB (Step 6), BTDT (Step 7), BTDT2 (Step 8), BTRD2 (Step 9) and DCOMPB (Step 10) is correct based on azimuth channel block diagrams. 3. BTDTL and BTDT2 are limited correctly based on azimuth channel block diagrams. RESULT: 1. OK 2. Calculation of BTR does not agree with block diagram. According to diagram, BTR should equal DTB + BOREAZ(ITRKR). 3. OK.

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-30	OBJECTIVE: Check calculation of Elevation Autopilot command, EK1. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 948. 3. Note the values of KGE, DCOMPE, and LAME. 4. Step to line 964, note the value of GDCMP. 5. Step to line 1035, note the value of COSG, GDCMY, SING, and EK1. 6. Repeat Step 2, step to line 878. 7. Set KGE to a value greater than GC(57) and observe the limiting of KGE. 8. Step to line 965, set GDCMP to a value greater than GC(59) and observe the limiting of GDCMP. 9. Step to line 1038, set EK1 to a value greater than GC(60) and observe the limiting of EK1. VERIFY: 1. Calculation of LAME1 (Step 3), GDCMP (Step 4), and EK1 (Step 5) is correct based on elevation channel block diagram. 2. KGE, GDCMP, and EK1 are limited correctly based on elevation channel block diagram. RESULT: OK
32-31	OBJECTIVE: Check calculation of azimuth autopilot command, EK2. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 949. 3. Note values of LAMB1, KGB, and DCOMPB. 4. Step to line 969, note the value of GDCMY. 5. Step to line 1036, note the values of GDCMP, SING, COSG, and EK2. 6. Repeat Step 2, step to line 881. 7. Set KGB to a value greater than GC(57) and observe the limiting KGB. 8. Step to line 970, set GDCMY to a value greater than GC(59) and observe the limiting of GDCMY. 9. Step to line 1041, set EK2 to a value greater than GC(60) and observe the limiting of EK2. VERIFY: 1. Calculation of LAMB1 (Step 3), GDCMY (Step 4), and EK2 (Step 5) is correct based on azimuth channel block diagram. 2. KGB, GDCMY, and EK2 are limited correctly based on azimuth channel block diagram. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-32	OBJECTIVE: Check for switch from WIDE to MEDIUM mode. PROCEDURE: 1. Run ESAMS using modified ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 978. 3. On first pass, LCHEK1 should be TRUE and RMS < CAPRNG, LWIDE still TRUE. 4. Repeat Step 2, set RMS = 170. 5. Observe LWIDE set to FALSE, LMED set to TRUE, LCHEK1 set to FALSE. VERIFY: Mode switches from WIDE to MEDIUM correctly. RESULT: OK
32-33	OBJECTIVE: Check for switch from Injection to Guide Mode for both azimuth and elevation. PROCEDURE: 1. Run ESAMS using modified ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 989. 3. Note the values of HSIGF, HBETF, HSIGTD, HBETFD. 4. Step to line 993, note the value of T and observe operation. 5. Repeat Step 2, set breakpoint at line 994. 6. Note the value of T. 7. Step to line 996, if necessary, change HSIFG to be less than GC(45) and HSIGFD to be less than GC(45). 8. Observe operation of lines 997 and 998. 9. Step to line 1002, if necessary, change HBETF and HBETF to be less than GC(45). 10. Observe operation of lines 1003 and 1004. 11. Return to DRVG8 on next pass and ensure lines 996 - 999 and 1002 - 1005 are omitted. VERIFY: 1. HSIGF, HBETF, HSIGFD, and HBETFD are set correctly in Step 3. 2. Operation skips from line 993 to 1008 at Step 4. 3. T is greater than GC(134) in Step 6. 4. LINJEL and LCHEK3 set to FALSE at Step 7. 5. LINJAZ and LCHEK4 set to FALSE at Step 10. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-34	OBJECTIVE: Check narrow beam selection. PROCEDURE: 1. Run ESAMS using modified ESAMS8.INP file. 2. Break into Subroutine DRVG8 at line 1012, note the values of LINJEL and LINJAZ. 3. If necessary, change SIGE to be less than GC(124) and SIGB to be less than GC(125). 4. Observe operation of lines 1014 to 1020. 5. Repeat Steps 2 and 3. 6. Step to line 1014, change the value of LATPHI. 7. Repeat Step 4. VERIFY: 1. LINTEL and LINTAZ are both FALSE in Step 2. 2. With LATPHI = FALSE, LNAROW is set to TRU, LMED is set to FALSE, and LCHEK2 is set to FALSE. 3. With LATPHI = TRUE, LNAROW is set to FALSE. RESULT: OK
32-35	OBJECTIVE: Check rotation of guidance command into fin planes. PROCEDURE: 1. Rewrite input file which requires the missile to turn. 2. Run ESAMS using modified ESAMS8.INP file. 3. Break into Subroutine DRVG8, step to line 1028. 4. Check the calculation of the variable TWIST at an early, mid, or late point in the engagement scenario. VERIFY: In all cases, twist angle correctly rotates guidance commands into fin planes. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-36	OBJECTIVE: Check MTR elevation calculation, BOR34M. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRV8, step to line 1052. 3. Note the value of GC(109), DTR, and BOR34M. 4. Set breakpoint for line 1055 (this occurs about T > 0.8). 5. Note the value of MSLEL. 6. Step to line 1071, note the value of FLTRWE. 7. Step to line 1073, note the value of FLTRME. 8. Step to line 1074, note the value of LWFDE (should be TRUE). 9. Step to line 1076, note the value of TCHFBE. 10. Step to line 1087, note the value of MMTRE. 11. Step to line 1099, note the value of TACHWE. 12. Step to line 1101, note the value of TACHME. 13. Step to line 1103, note the value of BOR34M. 14. Set breakpoint for line 1079 (this occurs when LWIDE is FALSE). 15. Note the values of FLTRME, TACHME, and TCHFBE. VERIFY: 1. BOR34M is initialized correctly when T < 0.8 (Step 3). 2. Calculation of MSLEL, FLTRWE, TCHFBE, TACHWE, MMTRE, and BOR34M is correct based on missile tracking loops for wide beam selection. 3. Calculation of FLTRME, TCHFBE, TACHME, MMTRE, and BOR34M is correct based on missile tracking loops for medium or narrow selection. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-37	OBJECTIVE: Check initialization of MTR variables. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file, time must be > 0.8 sec. 2. Break into Subroutine DRVG8, step to line 1058. 3. Noting the variables involved, observe the initialization of variables XI(50) - XI(55). 4. Observe the initialization of variables TACHWA, TACHWE, TACHMA, and TACHME. 5. Step to line 1089. 6. Noting the variables involved, observe the initialization of variables XI(56) - XI(59), XI(62), and XI(63). 7. Observe LCHEK5 being set to FALSE. 8. Repeat Step 2, observe operation. VERIFY: 1. Variables involved in updating the MTR are initialized properly. 2. On second pass through Subroutine, initialization procedure is inhibited. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-38	OBJECTIVE: Check MTR azimuth calculation, BOR34M. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRV8, step to line 1052. 3. Note the value of GC(104), DTR, and BOR34M. 4. Set breakpoint for line 1055 (this occurs about T > 0.8). 5. Note the value of MSLEL. 6. Step to line 1071, note the value of FLTRWE. 7. Step to line 1073, note the value of FLTRME. 8. Step to line 1074, note the value of LWFDE (should be TRUE). 9. Step to line 1076, note the value of TCHFBA. 10. Step to line 1087, note the value of MMTRE. 11. Step to line 1099, note the value of TACHWE. 12. Step to line 1101, note the value of TACHMW. 13. Step to line 1103, note the value of BOR34M. 14. Set breakpoint for line 1079 (this occurs when LWIDE is FALSE). 15. Note the values of FLTRME, TACHME, and TCHFBE. VERIFY: 1. BOR34M is initialized correctly when T < 0.8 (Step 3). 2. Calculation of MSLEL, FLTRWE, TCHFBE, TACHWE, MMTRE, and BOR34M is correct based on missile tracking loops for wide beam selection. 3. Calculation of FLTRME, TCHFBE, TACHME, MMTRE, and BOR34M is correct based on missile tracking loops for medium or narrow selection. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-39	OBJECTIVE: Check limiting of change in MTR azimuth angle, BOR14M. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRV8 (after several passes), step to line 1108. 3. Note the values of BR14MO, BOR14M, and TMP. 4. Step to line 1109, observe operation of IF statement. 5. Repeat Step 2, deposit the following values into BR14MO and BOR14M. BR14MOBOR14M 6.2 2.97 2.97 6.2 0.017 3.176 3.176 0.017 6. Note the final value of BOR14M for each case. VERIFY: BOR14M modified correctly. RESULT: OK - When the model is running “naturally” the MTR angle will not change by more than a few degrees on each pass making this correction seem unnecessary. It should be noted that BOR14M is not the same as inertial azimuth. For instance, negative values of BOR14M are possible when MTR rotates from North to South across 0° inertial azimuth and values larger than 2_ when MTR rotates in the opposite direction.
32-40	OBJECTIVE: Check calculation of state space values for Injection Mode, elevation channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 1115. 3. Observe the calculation of XD(1) - XD(4), and XD(7). VERIFY: 1. GC variables involved and equations agree with the appropriate transfer function. 2. Equations computed correctly. RESULT: OK
32-41	OBJECTIVE: Check calculation of state space values for Guide Mode, elevation channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 1119. 3. Observe the calculation of XD(5), (6), (11), (12) and XD(36). VERIFY: 1. GC variables involved and equations agree with the appropriate transfer function. 2. Equations computed correctly. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-42	OBJECTIVE: Check calculation of state space values for Injection Mode, azimuth channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 1130. 3. Observe the calculation of XD(16) - (19) and XD(22). VERIFY: 1. GC variables involved and equations agree with the appropriate transfer function. 2. Equations computed correctly. RESULT: OK
32-43	OBJECTIVE: Check calculation of state space values for Guide Mode, azimuth channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 1134. 3. Observe the calculation of XD(20), (21) and XD(37). VERIFY: 1. GC variables involved and equations agree with the appropriate transfer function. 2. Equations computed correctly. RESULT: OK
32-44	OBJECTIVE: Check calculation of state space values for Dynamic Compensation elevation channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 1122. 3. Observe the calculation of XD(8), (13), (26) and XD(28). VERIFY: 1. GC variables involved and equations agree with the appropriate transfer function. 2. Equations computed correctly. RESULT: OK
32-45	OBJECTIVE: Check calculation of state space values for Dynamic Compensation azimuth channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 1137. 3. Observe the calculation of XD(23), (27), (30) and XD(31). VERIFY: 1. GC variables involved and equations agree with the appropriate transfer function. 2. Equations computed correctly. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-46	OBJECTIVE: Check calculation of state space values for autopilot commands. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 1123. 3. Observe the calculation of XD(9), (10), (24) and XD(25). VERIFY: 1. GC variables involved and equations agree with the appropriate transfer function. 2. Equations computed correctly. RESULT: OK
32-47	OBJECTIVE: Check calculation of state space values for elevation bias. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 1128. 3. Observe the calculation of XD(14) and XD(15). VERIFY: 1. GC variables involved and equations agree with the appropriate transfer function. 2. Equations computed correctly. RESULT: OK
32-48	OBJECTIVE: Check calculation of state space values used to check for entry into guidance phase. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 1149. 3. Observe the calculation of XD(32) - (35). VERIFY: 1. GC variables involved and equations agree with the appropriate transfer function. 2. Equations computed correctly. RESULT: OK

TABLE 2.32-6. Software Test Cases for Command Guidance. (Contd.)

Test Case ID	Test Case Description
32-49	OBJECTIVE: Check calculation of state space values for MTR elevation channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 1157. 3. Observe the calculation of XD(51), (54), (55), (57), (59), (61) and XD(63). VERIFY: 1. GC variables involved and equations agree with the appropriate transfer function. 2. Equations computed correctly. RESULT: OK
32-50	OBJECTIVE: Check calculation of state space values for MTR azimuth channel. PROCEDURE: 1. Run ESAMS using ESAMS8.INP file. 2. Break into Subroutine DRVG8, step to line 1157. 3. Observe the calculation of XD(50), (52), (53), (56), (58), (60) and XD(62). VERIFY: 1. GC variables involved and equations agree with the appropriate transfer function. 2. Equations computed correctly. RESULT: OK

2.32.5 Conclusions and Recommendations

2.32.5.1 Code Discrepancies

Three discrepancies were found between the block diagrams provided in the documentation and the code. They are detailed as follows.

The variable BSUM1 which is the input into both Injection mode and Guide mode for the azimuth channel is computed in the code as, BSUM1 = SIGB*COS(BOREEL(ITRKR)). According to the Guidance Azimuth Block Diagram, BSUM1 = SIGB.

The variable DCOMPE which is the result of Dynamic Compensation for elevation is computed in the code as, DCOMPE = GC(56)*VZERO*(2.0*ETDTL + ETRD2). According to the Dynamic Compensation Block Diagram, DCOMPE = GC(56)*VZERO*(2.0*GC(56)*VZERO*ETDTL + ETRD2).

The variable BTR which is the input into Dynamic Compensation for the azimuth channel is computed in the code as, BTR = BOREAZ(ITRKR). According to the Guidance Azimuth Block Diagram, BTR = DTB + BOREAZ(ITRKR).

These are listed as discrepancies based on the assumption that the classified block diagrams which describe the system of interest were correct as provided in the external documentation. These three discrepancies will impact the output of the guidance routine which will result in minor deviation in the simulated missile trajectory. We recommend that the code be made to comply with the block diagrams or, if the diagrams are in error, they be made to comply with the code.

Another minor discrepancy uncovered while running a test is related to LOALT/LATPHI mode which is optical track mode. When conditions are right for LATPHI mode to be selected, the optical track flag IOPT is not set so track errors (AZERRT and ELERRT) are not set to zero. The impact of this is incorrect performance when in optical track mode.

2.32.5.2 Code Quality and Internal Documentation

Except for the discrepancy listed above, code quality is generally good. For the most part, subroutine DRVG8 adheres to the block diagrams rather well and is easy to follow when referring to the block diagrams.

Some of the internal documentation was incomplete or incorrect. Additional comments and corrections are recommended.

2.32.5.3 External Documentation

The Analyst's Manual and the User's Manual do not address Command Guidance.

The ESAMS classified Threat Manual contains some useful information concerning Command Guidance.

The ESAMS Verification Source Design Requirements (VSDR) document contains no numbered equations which can be directly tied to the code. The discussion of angular inputs which is included under Design Element 32-1 should be a separate design element because these calculations apply to both Injection and Guide mode. Two additional Design elements should be included, one addressing the adjustment, filtering and rotation of the output guidance commands and the other addressing the missile tracking radar.